# CHAPARRAL VEGETATION TYPE

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Southwestern Region
Forest Service
April 1970

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# CHAPARRAL VEGETATION TYPE

## INTRODUCTION

Between 5-1/2 and 6 million acres of the Southwestern Region are covered by the chaparral vegetation type. Elevations vary from 3,600 to 6,500 feet between the lower, drier southern desert shrub formation and the ponderosa pine-Douglas fir at the higher elevations. Precipitation ranges from 16 to 25 inches with approximately 45 percent falling during the summer and 55 percent in winter (Pase, 1966). Shrubs often root to a depth of 33 feet or more (Pase et al, 1967).

Chaparral closely resembles a Mediterranean vegetation type in that it requires fall and early winter moisture as well as spring moisture. The areas occupied by chaparral in the Southwestern Region are characterized by rainfall at these two seasons of the year.

Chaparral reaches its best development at Sierra Ancha Experimental Forest on diabase - derived soils between 4,500 and 6,000 feet elevation. Where soils are thin, overlying massive unfractured quartzite, chaparral stands become more open with interspersed islands of grassland and forbs (Pase and Johnson, 1968).

With few exceptions, characteristic chaparral shrubs are evergreen, broad sclerophylls. Most have deep, extensive root systems and the ability to resprout vigorously after fire. The few non-sprouting shrubs produce abundant seeds which germinate readily after fire (Page, 1965).

The most extensive and continuous forests of chaparral occur on the southern side of the main ponderosa pine body where the mountain slopes drop away to lower elevations and higher temperatures. Smaller bodies of typical chaparral growth are found throughout southern and eastern Arizona on the slopes of the isolated mountain ranges, occurring above the grass and below the ponderosa pine. Chaparral is characterized by shrubs and stunted trees, much of the cover being so dense it is impenetrable to man or horse. Differences in soils, elevations, and exposures produce differences in the floral structure and dominance. Many areas can only be described as a heterogeneous association. More than one or two species dominate the type to give it a specific character (Nichol, 1937).

## PLANT ECOLOGY

Various writers have suggested that chaparral as a vegetation type has not increased in acreage over the years, rather it has merely thickened and closed in upon itself as a result of disturbance. Overgrazing and periodic wildfires over a period of years have probably been the biggest contributor to this particular process.

Wildfires have periodically swept through the chaparral in the past. Small areas (1-3%) within the type have been burned from once to several times. This has resulted in some very heterogeneous stands of chaparral from the standpoint of composition. Islands of pure stands of individual species such as Arctosaphylos or Ceanothus occur interspersed in large areas of mixed species. Mixed stands also occur having one predominant species, and other stands are similar composition-wise but are highly variable in height class and density.

The chaparral area is a complex ecosystem of highly variable ecotypes and plant communities. It has been stated that chaparral is a structural form rather than a successional stage. There are two prevailing theories concerning the type: (1) That the chaparral vegetation type exists primarily as a fire climax; and (2) that chaparral once existed as a climax on certain sites and as mottes throughout other climaxes, but exists primarily as a dis-climax due to disturbance of the pre-existing climax.

The second theory has the widest range of acceptance. Leopold (1924) indicates that overgrazing and the inability of the land to carry fire resulted in chaparral moving out of its normal zone into the lower grasslands and upward into the woodland and timber zones.

There are three primary methods of reproduction in chaparral: (1) Root crown sprouters - the majority of species fall into this category; (2) seed producers - several species fall in this category but those of most interest are Arctoslaphylos, Ceanothus, and Cercocarpus; and (3) root sprouters - the only active root sprouter in the community is Eriodyction.

The great majority of chaparral species are crown sprouters of one intensity or another. Three notable exceptions are:

A. Manzanita - This species does not produce seed until it is about 15 years of age. After that, however, it is very prolific. Manzanita is a non-sprouter and an initial hot fire will usually eliminate the growing plants. The seed remains viable for many years in the soil and requires fire and heat for appreciable germination. In a balanced tree-brush-grass community, there is little evidence of manzanita. However, the large quantities of seed lying in the soil may dominate a site following the initial fire. In most cases, the second or third fire kills the thick stand of young seedlings and virtually eliminates the species.

B. Desert Ceanothus - This species produces seed at about 10 years of age. It is short-lived and dies out in the absence of fire. The seed requires fire and heat for germination. In some cases, seeds lying in the soil have dominated a site following wildfire.

C. Yerba Santa - This species is both a seed producer and a very active root sprouter. Initial burning scarifies the seed and stimulates root sprouting so that the species becomes one of the more abundant plants, or may even dominate the site. This species is also usually eliminated by the second or third burn.

Research on the ecology of chaparral is practically non-existent. There are numerous publications relating to the effects of fire, chemical herbicides, and wildlife.

Chaparral is probably the most variable vegetation type in that it extends from within the fir type down to the desert-grassland type.

A few of the more predominant species of the chaparral site (McCulloch and Pase, 1963 - 440 plants tentatively identified on the 3-Bar Watershed) are listed below:

| BOTANICAL NAME | COMMON NAME |
|---|---|
| Arctostaphylos pringlei | Pringle manzanita |
| Arctostaphylos pungens | Pointleaf manzanita |
| Ceanothus greggii | Desert Ceanothus |
| Ceanothus integerrimus | Deerbrush |
| Cercocarpus brevifolius | Hairy Mountainmahogany |
| Cercocarpus betuloides | Birchleaf Mountainmahogany |
| Cercocarpus montanus | True Mountainmahogany |
| Cupressus arizonica | Arizona cypress |
| Eriodictyon angustifolium | Yerba santa |
| Garrya flavescens | Yellowleaf silktassel |
| Garrya wrightii | Wright silktassel |
| Juniperus deppeana | Alligator juniper |
| Mimosa biuncifera | Mimosa |
| Nolina microcarpo | Sacahuista |
| Pinus edulis | Pinyon |
| Pinus monophylla | Single-leaf pinyon |
| Quercus emoryi | Emory oak |
| Quercus palmeri | Palmer oak |
| Quercus gambellii | Gambels oak |
| Quercus turbinella | Shrub live oak |
| Quercus undulata | Wavy-leaf oak |
| Rhamnus crocea | Hollyleaf buckthorn |
| Rhus trilobata | Skunkbush Sumac |
| Rhus ovata | Sugar sumac |
| Yucca spp. | Yucca |

## Soils

Soils are the most important inventory aspect when considering treatment for water yield improvement or land treatment practices.

Soils derived from quartzite were shallow and contained considerable amounts of clay. Islands of grass were present in the chaparral on this soil before treatment. Following shrub control with herbicides, the cover of all understory vegetation on quartzite soil increased, but increase in grass cover was quickest and most spectacular. Half shrubs and forbs increased less rapidly, but continuously. Increase in grass production was also greater on this soil (Pond, 1964).

Soils derived from diabase were deep and sandy. They supported no islands of grass in the chaparral. Here, half-shrubs increased greatly in cover and production following control of overstory shrubs. Grasses showed little, if any, response, while forbs increased in cover somewhat more than on quartzite soils (Pond, 1964).

The disjunct distribution, reproduction, and rooting habits of Quercus turbinella in the Arizona chaparral were studied on quartz diorite, sedimentary, and volcanic substrata. The oak was less dense on the sediments and volcanics than on quartz diorite. Lower densities on the bedded sediments resulted from restricted root penetration which prevented access to deep soil moisture. On the volcanic substratum, heavy clay soils gave an overall poorer moisture regime than soils developed from the quartz diorite. Shrubs growing on the less favorable sedimentary and volcanic substrata probably were more susceptible to damage by drought and fire, and low mobility and low seedling production tended to eliminate the species from these areas. It is suggested that the Q. turbinella "islands" within large areas of grassland are relics rather than evidence of invasion (Saunier and Wagle, 1967).

## ANIMAL ECOLOGY

A discussion of how wildlife populations fit into the ecology of a chaparral area must be prefaced by the understanding of how plant succession and interspersion of types affect wildlife habitat.

Quotations from Aldo Leopold's book "Game Management" appears to give us the background understanding needed. Wildlife species fit into an ecological scale pattern, just as plants do. A few species are definitely associated with all stages including climax; but as Mr. Leopold clearly points out - "A MAJORITY OF GAME SPECIES ARE ASSOCIATED WITH AN INTERSPERSION OF THE EARLY AND INTERMEDIATE STAGES OF PLANT SUCCESSION."

To explain the importance of interspersion of types, Leopold compares man's need for interspersion with that of wildlife.

> "A city includes all of the environmental (types) which human animals require for thrift and welfare. If, however, all the kitchens were situated within one quarter of a given city, all the bedrooms in another quarter, all the restaurants and dining-rooms in a third, and all the parks and golf courses in the last quarter, the human population which it would be capable of supporting would be considerably reduced. The extent of the reduction would vary inversely to the mobility of the inhabitants. In fact, it is only the recent artificial extension of the human cruising radius by means of mechanical transportation that would allow such a city to be inhabited at all.

> Likewise with game. The game must usually be able to reach each of the essential types each day. The maximum population of any given piece of land depends, therefore, not only on its environmental types or composition, but also on the interspersion of these types in relation to the cruising radius of the species. Composition and interspersion are thus the two principal determinants of potential abundance on game range."

In explaining the law of interspersion, Leopold states "Game is a phenomenon of edges. It occurs where the types of food and cover which it needs come together, i.e., where the edges meet. We do not understand the reason for all of these edge effects, but in those cases where we can guess the reason, it usually refers back either to the desirability of simultaneous access to more than one environmental type, or the greater richness of border vegetation, or both."

Game populations are quite low, especially in dense, unbroken chaparral. White tailed deer (Odocoileus virgenianus covesi) and mule deer (Odocoileus hemionus), the most important big game animals, may occur at a density of only 10 per square mile where herbaceous cover or palatable shrubs are sparse (Pase, et al, 1967).

Locally in Arizona chaparral, deer populations vary from 20 to 30 per square mile to 4 to 5 per square mile. The high populations invariably are found in what is designated as the mixed shrub type. This type is dominated by turbinella oak, but contains a good quantity of other plants high in palatability and in nutritive value. Mountainmahogany, desert ceanothus, and hollyleaf buckthorn make up as much as 35 percent of the tall shrub layer. The low population levels usually are found in what is known as the turbinella oak-skunkbush type where the two species, turbinella oak and skunkbush, make up practically the entire shrub cover. Plants of high nutritive value and palatability occur sporadically or not at all. Taking Arizona chaparral as a unit, the deer density has been calculated at only 10 per square mile. The population is kept at this low level due to a shortage of herbaceous material and the occupancy of the area by dense unbroken stands of turbinella oak, skunkbush, manzanita, sugar-sumac, and other nonpalatable shrubs which are low in nutritive value (Swank, 1958).

Palatability of most chaparral shrubs for domestic livestock is thought to be low. Of the major dominants, shrub live oak is taken to a limited extent, especially the sprouts after a fire. Skunkbush, sugar-sumac, birchleaf mountainmahogany, and Emory and Arizona oak are little used by domestic livestock or game, except for fruits. A number of species, noteworthy among which are deerbrush, hollyleaf buckthorn, desert ceanothus and true mountainmahogany, are relished by both livestock and game, and chaparral stands with fair amounts of these species are considered desirable range, especially for deer (Swank, 1958).

Studies of foods used by deer suggested the need for a variety of vegetation types within each animal's home range. Neither mule nor white-tailed deer relied yearlong on a single life form, let along a single species of food plant, but there were certain food classes which appeared more important than others during a given season. There were apparent dietary differences between the two deer species, although there was a degree of overlap in food species used just as there is overlap in use of areas (McCulloch, 1964).

Acorns, beans, berries, forbs, and foliage with young twigs of low and tall shrubs were much eaten by deer, although they notably avoided certain plant species which were abundantly available and potentially edible (McCulloch, 1964).

Shrub live oak, birchleaf mountainmahogany, and Wright silktassel of the Arizona chaparral grew in spring until soil moisture was exhausted. Additional, but a lesser amount of growth was made on summer rainfall. Although there was some variation among species, moisture, crude protein, and phosphorus were highest in early spring and, except for slight summer increases, gradually decreased in later seasons, sprout use was heaviest during late spring when herbaceous vegetation was mostly dry, with mountainmahogany preferred. Sprout selection was associated with high moisture and crude protein, low crude fiber, and a comparatively wide calcium-phosphorous ratio (Reynolds, 1967).

Herbicide treatment to suppress brush regrowth after wildfire depleted the principal foods selected by deer during fawning and start of the nursing season. The treatment greatly increased grasses of which most deer ate but little in proportion to the general availability of grasses. Chemical brush control on a small area (76 acres) left it as attractive to deer as one untreated area, at least during some seasons of the year, and more attractive than some other untreated areas, despite adverse treatment effect on one seasonal food source (McCulloch, 1964).

Pellet group distribution patterns indicated localized site preferences of deer within the untreated chaparral vegetation type and also within a herbicide treated area. These apparent preferences were not generally associated with particular slope factors nor with presence of single shrub species (McCulloch, 1966).

Blacktailed deer populations were studied under three different conditions of chamise brushland: (1) Heavy brush cover protected from fire; (2) wildfire burn; and (3) opened brush, consisting of an interspersion of grass with patches of dense brush. Number of deer in the heavy brush averaged 10 to 30 to the square mile; in the wildfire burn 5 to 160; and in the opened brush about 40 to 110. Populations in the heavy brush and opened brush were rather stable; but in the wildfire burn large numbers of deer moved in when the sprouts were young and tender and out during

cold weather. In adult does the ovulation rates were: Heavy brush 84 percent, wildfire burn 116 percent; opened brush 147 percent. Ratios of fawns to 100 does following the rut were: Heavy brush about 60 to 85; wildfire burn 100 to 110; opened brush 115 to 140 (Biswell, et al, 1952).

A. Cover Requirements: The Black Canyon Highway in Arizona is the main dividing line between the three principal deer. To the north and west are found the Rocky Mountain mule deer. To the east and south are found the Desert mule deer and the white-tailed deer. Consequently, in the chaparral on the Prescott National Forest we have the Rocky Mountain mule deer. On the Tonto a mixture of Desert mule deer and white-tailed deer is found. And, on the Coronado the white-tailed deer, Desert mule deer, and Rocky Mountain mule deer are all found.

Chaparral is occupied yearlong by resident populations of both mule and whitetailed deer, but here again, climate may force increased use of the type under certain conditions.

Bear are generally found in the upper limits of the chaparral. They spend a large portion of their time on north slopes where height and density of cover is more to their liking.

Turkeys are rare or absent in the "interior" chaparral, but are found in the tree-like chaparral around the more watered sites. Band-tailed pigeons are found here also.

Although there are exceptions when antelope, javelina and Gambel quail occupy the chaparral, they are principally found in the fringe areas. When this area is converted to grass, dove move in, in large quantities. Dead chaparral serves as roosting places and most conversions have large quantities of weeds which provide food.

It would be well to discuss the cover requirements and forage conditions of the chaparral in general from a wildlife standpoint.

Actual cover requirements of these species are unknown, but the white-tail appear to be better adapted to the heavy cover than the mule. White-tailed deer do make heavy use of the opening in the 3-Bar study, but the way mule and white-tail use the chaparral type, it is reasoned that white-tail utilizes a heavier cover to opening ratio than the mule deer.

The cover opening ratio or "edge" as defined by Leopold is extremely important as is the varied ecological successional stages the vegetative type must go through from controlled burning back to maturity. This importance is difficult to define, but is very real.

Based on the above, our best estimate is that in white-tail range, up to 50 percent of the type could be treated, while in mule deer range, up to 70 percent could be treated provided suitable leave patterns were

included. These figures are based on the assumption that the pattern of treatment would call for maximum "edge." We should recognize that such treatment may be detrimental to the cover requirements of black bear, but again proper conversion patterns can be helpful in minimizing the impact.

Wildlife benefits of this program can be amplified if the type can be forced to undergo continued change. The opposite will be true if the objective is to maintain the converted acreage in another type without allowing for the successional stages (Tables 1 and 2, Figure 1).

B. Browse Condition: The composition, density, vigor and availability of forage are important items in the chaparral. These items collectively comprise browse condition and may be determined through transect evaluation.

One final wildlife problem that relates to the chaparral type in general is access. This does not necessarily refer to road access, but rather to the hunter's ability to "hunt" the area. Under untreated conditions, only a minor acreage of the chaparral can be hunted. This situation can be greatly improved through proper management of the type.

Table 1. Seasonal variations in relative volumes of foods in mule deer rumens, Three Bar Wildlife Area. 1/ (McCulloch, 1964)



| Foods | Stage of Deer Life Cycle | Fawning and Nursing; Antler Growth | Nursing and Weaning | Pre-Breeding Period | Breeding | Early Gestation | Late Gestation; Antler Growth |
|---|---|---|---|---|---|---|---|
| | Season | Mid-Summer | Early Fall (warm) | Late Fall (cool) | Mid-Winter | Late Winter-Early Spring | Late Spring Early Summer (dry) |
| | | % | % | % | % | % | % |
| Tall Shrub Fruits | | 69 | 0 | t | No Records | 0 | No Records |
| Forbs | | 5 | 6 | 4 | No Records | 63 | No Records |
| Low Browse | | 7 | 63 | 23 | No Records | 11 | No Records |
| Tall Browse | | 9 | 16 | 49 | No Records | 15 | No Records |
| Grasses | | t | t | 4 | No Records | 2 | No Records |
| Miscellaneous | | 3 | 0 | 2 | No Records | 0 | No Records |
| Unidentifiable Mass | | 7 | 15 | 18 | No Records | 9 | No Records |
| Total | | 100 | 100 | 100 | No Records | 100 | No Records |
| | | (7) | (21) | (45) | (0) | (5) | (0) |

1/ Number of examined rumens indicated in parentheses.

Table 2. Seasonal variations in relative volumes of foods in whitetailed deer rumens, Three Bar Wildlife Area. 1/ (McCulloch, 1964)

| Foods | Stage of Deer Life Cycle | Fawning and Nursing; Antler Growth | Nursing and Weaning | Pre-Breeding Period | Breeding | Early Gestation | Late Gestation; Antler Growth |
|---|---|---|---|---|---|---|---|
| | Season | Mid-Summer | Early Fall (warm) | Late Fall (cool) | Mid-Winter | Late Winter-Early Spring | Late Spring-Early Summer (dry) |
| | | % | % | % | % | % | % |
| Tall Shrub Fruits | | 76 | No Records | 2 | No Records | 0 | No Records |
| Forbs | | 4 | No Records | 39 | No Records | 27 | No Records |
| Low Browse | | 3 | No Records | 28 | No Records | 8 | No Records |
| Tall Browse | | 9 | No Records | 15 | No Records | 32 | No Records |
| Grasses | | t | No Records | 4 | No Records | 6 | No Records |
| Unidentifiable Mass | | 8 | No Records | 22 | No Records | 27 | No Records |
| Total | | 100 | No Records | 100 | No Records | 100 | No Records |
| | | (5) | (0) | (10) | (0) | (9) | (0) |

1/ Number of examined rumens indicated in parentheses.

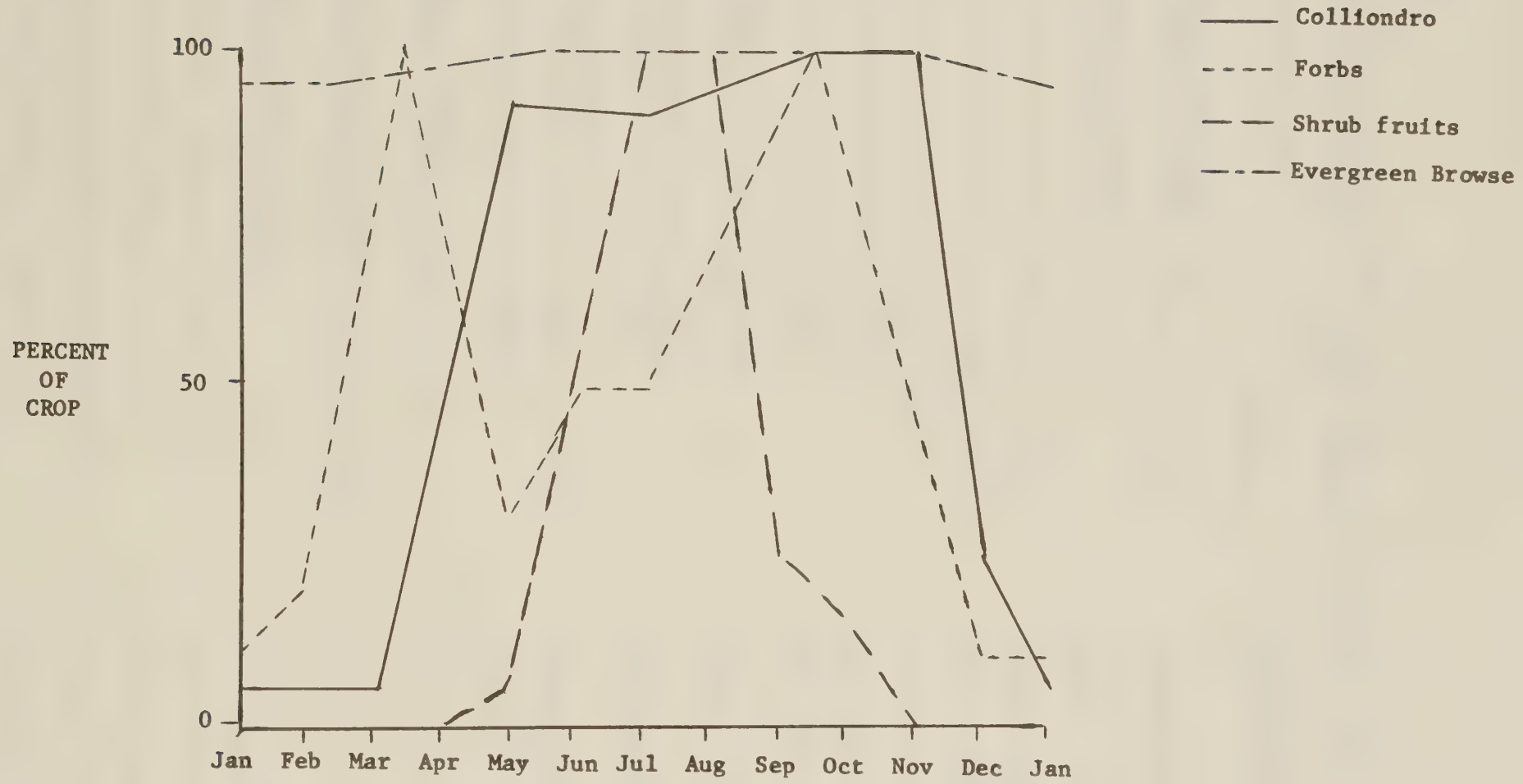


FIGURE 1. SEASONAL AVAILABILITY OF MAJOR DEER FOODS, THREE BAR AREA (McCULLOCH, 1967)

A list of reptiles, birds, and mammals that have been observed in the chaparral vegetation type are: (Reynold and Johnson, 1965)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| **REPTILES** | |
| Gekos (Gekkonidae) | |
| Coleonyx variegatus (Baird) | Banded gecko |
| Iguanas (Iguanidae) | |
| Crotaphytus collaris (Say) | Collared lizard |
| Holbrookia texana (Troschel) | Greater earless lizard |
| Sceloporus clarki (Baird and Girard) | Clark's spiny lizard |
| Sceloporus undulatus (Latreille) | Eastern fence lizard |
| Uta ornata (Baird and Girard) | Tree lizard |
| Phrynosoma douglassi (Bell) | Short-horned lizard |
| Lateral fold lizards (Anguidae) | |
| Gerrhonotus kingi (Gray) | Arizona alligator lizard |
| Beaded lizards (Helodermatidae)* | |
| Heloderma suspectum (Cope) | Gila Monster |
| Teids (Teidae) | |
| Cnemidophorus tigris (Baird and Girard) | Western whiptail |
| Cnemidophorus sacki (Wiegmann) | Spotted whiptail |
| Skinks (Scincidae) | |
| Eumeces obsoletus (Baird and Girard) | Great Plains skink |
| Blind snakes (Leptotyphlopidae) | |
| Leptotyphlops humilis (Baird and Girard) | Western blind snake |
| Colubrids (Colubridae) | |
| Thamnophis eques (Reuss) | Mexican garter snake |
| Masticophis bilineatus (Jan.) | Sonora whipsnake |
| Masticophis taeniatus (Hallowell) | Striped whipsnake |
| Salvadora grahamiae (Baird and Girard) | Mountain patch-nosed snake |
| Pituophis catenifer (Blainville) | Gopher snake |

*On the rare and endangered species list.

| | |
|---|---|
| Lampropeltis pyromelana (Cope) | Sonora mountain kingsnake |
| Hypsiglena torquata (Gunther) | Night snake |
| Tantilla atriceps (Gunther) | Mexican black-headed snake |
| Pit vipers (Crotalidae) | |
| Crotalus molossus (Baird and Girard) | Black-tailed rattlesnake |
| Crotalus viridis (Rafinesque) | Western rattlesnake |

BIRDS

| | |
|---|---|
| American vultures (Cathartidae) | |
| Cathartes aura (Linnaeus) | Turkey vulture |
| Hawks, old-world vultures and harriers (Accipitridae) | |
| Accipiter gentilis (Linnaeus) | Goshawk |
| Buteo jamaicensis (Gmelin) | Red-tailed hawk |
| Quails, pheasants, and peacocks (Phasianidae) | |
| Lophortyx gambelii (Gambel) | Gambel's quail |
| Cyrtonyx montesumae (Vigors) | Harlequin quail |
| Turkeys (Meleagridioae) | |
| Meleagris gallopavo (Linnaeus) | Turkey |
| Pigeons and doves (Columbidae) | |
| Columba fasciata (Say) | Band-tailed pigeon |
| Zenaidura macroura (Linnaeus) | Mourning dove |
| Roadrunners (Cuculidae) | |
| Geococcyx californianus (Lesson) | Roadrunner |
| Typical owls (Strigidae) | |
| Otus asio (Linnaeus) | Screech owl |
| Bubo virginianus (Gmelin) | Great horned owl |
| Micrathene whitneyi (Cooper) | Elf owl |
| Goatsuckers (Caprimulgidae) | |
| Caprimulgus vociferus (Wilson) | Whip-poor-will |
| Phalaenoptilus nuttallii (Audubon) | Poor-will |

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|---|---|
| **Swifts (Apodidae)** | |
| Aeronautes saxatalis (Woodhouse) | White-throated swift |
| **Hummingbirds (Trochilidae)** | |
| Archilochus alexandri (Bourcier and Mulsant) | Black-chinned hummingbird |
| **Tyrant flycatchers (Tyrannidae)** | |
| Tyrannus verticalis (Say) | Western kingbird |
| Tyrannus vociferans (Swainson) | Cassin's kingbird |
| Myiarchus cinerascens (Lawrence) | Ash-throated flycatcher |
| **Jays, magpies, and crows (Corvidae)** | |
| Cyanocitta stelleri (Gemelin) | Steller's jay |
| Aphelocoma coerulescens (Bosc) | Scrub jay |
| Corvus corax (Linnaeus) | Common raven |
| **Titmice and Bushtits (Paridae)** | |
| Parus gambeli (Ridgway) | Mountain chickadee |
| Parus inornatus (Gambel) | Plain titmouse |
| Psaltriparus minimus (Townsend) | Common bushtit |
| **Wrens (Troglodytidae)** | |
| Troglodytes aedon (Vieillot) | House wren |
| Thryomanes bewickii (Audubon) | Bewick's wren |
| Catherpes mexicanus (Swainson) | Canyon wren |
| Salpinctes obsoletus (Say) | Rock wren |
| **Mockingbirds and thrashers (Mimidae)** | |
| Mimus polyglottos (Linnaeus) | Mockingbird |
| **Solitaires (Turdidae)** | |
| Turdus migratorius (Linnaeus) | Robin |
| Myadestes Townsendi (Audubon) | Townsend's solitaire |
| **Gnatcatchers, and kinglets (Sylviidae)** | |
| Polioptila caerulea (Linnaeus) | Blue-gray gnatcatcher |
| Regulus calendula (Linnaeus) | Ruby-crowned kinglet |

| | |
|---|---|
| Waxwings (Bombycillidae) | |
| Bonbycilla cedrorum (Vieillot) | Cedar waxwing |
| Shrikes (Laniidae) | |
| Lanius ludovicianus (Linnaeus) | Loggerhead shrike |
| Vireos (Vireonidae) | |
| Vireo huttoni (Cassin) | Hutton's vireo |
| Vireo vicinior (Coues) | Gray vireo |
| Wood warblers (Parulidae) | |
| Vermivora celata (Say) | Orange-crowned warbler |
| Dendroica auduboni (Townsend) | Audobon's warbler |
| Orioles (Icteridae) | |
| Icterus cucullatus (Swainson) | Hooded oriole |
| Icterus parisorum (Bonaparte) | Scott's oriole |
| Molothrus ater (Boddaert) | Brown-headed cowbird |
| Grosbeaks, finches, sparrows, and buntings (Fringillidae) | |
| Richmondena cardinalis (Linnaeus) | Cardinal |
| Carpodacus mexicanus (Muller) | House finch |
| Chlorura chlorura (Audubon) | Green-tailed towhee |
| Pipilo erythrophthalmus (Linnaeus) | Rufous-sided towhee |
| Piplo fuscus (Swainson) | Brown towhee |
| Junco hyemalis (Linnaeus) | Slate-colored junco |
| Spizella atrogularis (Cabanis) | Black-chinned sparrow |
| Zonotrichia leucophrys (Forster) | White-crowned sparrow |

## MAMMALS

| | |
|---|---|
| Bats (Chiroptera) | |
| Myotis keeni (Merriam) | Northern brown bat |
| Myotis californicus (Audubon and Bachman) | California brown bat |
| Myotis subulatus (Say) | Masked brown bat |

| | |
|---|---|
| Pipistrellus hesperus (Allen) | Western pipistrelle |
| Eptesicus fuscus (Beauvois) | Big brown bat |
| Tadarida mexicana (Saussure) | Mexican freetail bat |
| **Rodents (Rodentia)** | |
| Sciurus aberti (Woodhouse) | Tassel-eared squirrel |
| Sciurus arizonensis (Coues) | Arizona gray squirrel |
| Citellus variegatus (Erxleben) | Rock squirrel |
| Eutamias dorsalis (Baird) | Cliff chipmunk |
| Peromyscus boylei (Baird) | Brush mouse |
| Neotoma albigula (Hartley) | White-throated packrat |
| **Flesh-eaters (Carnivora)** | |
| Canis latrans (Say) | Coyote |
| Urocyon cinereoargenteus (Schreber) | Gray fox |
| Ursus americanus (Pallas) | Black bear |
| Bassariscus astutus (Lichtenstein) | Ringtail |
| Mephitis mephitis (Schreber) | Common striped skunk |
| Conepatus mesoleucus (Lichtenstein) | Western rooter skunk |
| Lynx rufus (Schreber) | Bobcat |
| **Even-toed ungulates (Artiodactyla)** | |
| Tayassu tajacu (Linnaeus) | Collared peccary |
| Odocoileus virginianus (Zimmermann) | Whitetail deer |
| Odocoileus hemionus (Rafinesque) | Mule deer |

## EFFECTS OF FIRE ON CHAPARRAL

Chaparral is highly adapted to withstand fire. While it burns readily during periods of high fire hazard, most shrubs sprout vigorously, or have seeds whose germination is greatly increased by heat scarification. After fire, herbaceous cover builds up rapidly, but is typically of short duration as shrub sprouts soon regain dominance (Pase, et al, 1967).

When fire sweeps through a chaparral stand, the plants are killed back to ground level and largely resprout from the root crown. Associated with this initial fire is a tremendous increase in manzanita and ceanothus seedlings (due to scarification of the seeds by fire) and yerba santa (the only active root sprouter). Repeated burning results in a deterioration of the composition of the stand from the standpoint of desirable forage species. Ceanothus and Arctostaphylos are the first to be destroyed and are virtually non-existent after the second or third hot fire. Cercocarpus and Rhus, both of which are weak crown sprouters, are the next to go. The intermediate crown sprouters (Garrya) and Rhamnus die out next. Oak (Quercus) is the strongest sprouter and would be the major species to survive. Repeated burning over an extended period of time would tend to convert a mixed chaparral site to a pure stand of oak, mimosa, yucca or a combination of any or all of these plants (Pase, 1970). Fire resulted in more brush seedlings and sprouts and better range for deer. However, fire must be used judiciously or the nonsprouting species will be diminished in abundance and the carrying capacity may be decreased." (Biswell and Gilman, 1961)

A chaparral fire on the Three Bar watersheds, Tonto National Forest, caused deer use to decline after the burn. Few deer died in the fire, but their food supply was temporarily destroyed. Deer numbers apparently increased on nearby unburned areas (McCulloch, 1960).

The use of fire to break up stands of mature Pringle manzanita may result in seedlings of less desirable species, which may be in part offset by an increase in certain shrubs that are highly desirable as game forage. Additional control techniques to improve the composition of replacement vegetation are badly needed before fire is widely used in such areas (Pase, 1965).

One burn was sufficient to kill most of the old desert ceanothus plants. Seedlings were observed coming in on the burned plots over the years. Also, two of the old plants definitely sprouted on the plots treated at 2-year intervals. These were the only sprouts of this species observed. These were eliminated by the second burn. (Pond and Cable, 1960)

Five years after the burn, sprouting shrubs had regained density that approximated shrub densities on unburned chaparral type. Shrubs most valuable as forage for livestock or game, such as desert ceanothus and hollyleaf buckthorn, constituted only a very small part of the cover. (Cable, 1957)

When a hot fire sweeps through chaparral, the ground cover is virtually destroyed. In the absence of ground cover, the stand will not burn again for a minimum of 20-30 years. This time is required for the establishment of litter cover, twigs, etc., on the ground to carry the fire.

Because of the generally steep slopes, the nature of parent geologic materials, the young immature soils, and the inherent scarcity of herbaceous plant cover, potential sediment movement rates on many chaparral sites are high. (Glendening, 1959)

A chaparral fire can greatly change the functioning of a watershed. Only vestiges remain of the vegetation that has held these mountain soils in place. There is no canopy of interlocking tops of bushes to break the force of driving rainstorms; the scanty remnant of scorched but unconsumed shrub skeletons have but little effect on interception. These charred stems and the incomplete layer of ashes also have little effect in slowing down water running over the surface. (Chapline, et al, 1959)

During the first 21 months after the chaparral cover was burned by wildfire, bedload sediment yields equivalent to 49,839, 21,519, and 64,446 tons per square mile have been measured on 3-Bar experimental watersheds respectively. (Glendening, et al, 1961)

## PAST HISTORY

"Historical materials are so diverse in their content that in the hands of an uncritical researcher they may be (and, in fact, frequently are) used to 'prove' whatever the research desires." (Hastings, 1959)

A history of grazing on the Tonto National Forest, prepared in 1926 by Senior Ranger Fred W. Croxen, gives some outstanding accounts of early day vegetation on the Tonto National Forest. This history was developed through personal contacts with 19 early-day cattlemen of which only one was surviving in 1926. Following is a brief summary of the more important facts of this paper. (The complete paper is on file in the Division of Range and Wildlife.)

Interest in central Arizona was not established to any great extent until shortly after the Civil War. The first settlers into the area were basically prospectors, traders and packers who were following the troops. By 1875, the cattle were beginning to show up in the area and numbers were increasing very rapidly.

Sheep started to show up in about 1880. All old timers agreed that the range was fully stocked by about 1890 with a peak in numbers reached in about 1900. In 1926, the statement was made that where there is one cow now, there were 15 to 20 in 1900. As a result of the 1904 drought, cattle numbers were reduced to a much lower level and have <u>never</u> built back up to the point they were prior to the drought.

Descriptions of the vegetation prior to the great herds of cattle all mention the tremendous amount of open grassland with very little brush present. Some quotes from Mr. Croxin's paper are as follows:

> "The Pine Bunchgrass grew all over Sierra Anchas in the pine type and lower down than the pine timber on the North Slopes."
>
> "All the men interviewed state that there was little brush in the country at the time stock was first brought in and it was possible to drive a wagon nearly anywhere one desired."
>
> "Nearly all of the north slope of Mt. Ord was a pine bunchgrass country. At present, this is one of the brushiest pieces of range on the Tonto."
>
> "The influx of Texans and others killed much of the Pine grass by following their former methods of the plains by burning the old mature grass." These individuals were located on Moore Creek, Ellison Creek and the head of the East Verde.
>
> "In summary, 'to quote the last words of Florence Packard when he finished telling me of old time conditions is used - 'The range is not overstocked at present; it is just worn out and gone' and such is the case. While man, the most destructive of animals, brought his herds to a virgin range, only fifty years ago, and abused it in every way he could. We see the result today."

This same document contained a few interesting remarks concerning the status of wildlife during those early days when vegetative types obviously did not resemble the situation we have today. "He says there were beaver in the streams in Tonto Basin in the early days, but they were not trapped out by white men. The floods caused by the denuding of the ranges finally washed them out. There was an occasional wolf in the late 1870's and early 1880's and quite a few lion, but the lions did not bother the stock as deer were very plentiful, deer being the natural animal for them to prey on. He says one could ride from Pine to the East Verde settlement and see deer on every point."

## PLANT-SOIL-WATER AND ANIMAL RELATIONSHIPS

For purposes of classification, treatment, use, and water yield, the chaparral vegetation type falls roughly into three very broad plant-soil-water relationship groups. Within any given group there are wide differentiations of height, density, and composition depending upon the degree and depth of soil formation and other ecological factors.

A. Where Chaparral Has Reached or Will Reach Climax. These soils are classified as poor due to weak development or the complete absence of development. They are broken into two categories based on productivity.

A1. Shallow Soils Overlying Fractured Rock. Chaparral soils such as these are: Moano (Schist); Oneida (Metamorphosed shale); Cabezon (Basalt); Venezia (Basalt); and Elledge (Sandstone).

Chaparral as a climax type generally occupies light textured shallow soils overlying deeply fractured parent material. Such a situation precludes eventual dominance by grass due to the plant-soil-water relationship. It also precludes the eventual dominance of tree species due to the above plus the competition of the extensive deep roots of the chaparral species.

Persistence of grass and forbs following good germination and seedling emergence is not good due to the poor soil-water relationship. The grass becomes a sparse stand of wolf plants which lends itself to a rapid re-establishment of chaparral. Grass in even a fair condition cannot persist for an extended period under such conditions and the site reverts back to the better adapted, deep rooted chaparral. Closing in of the overstory canopy is also a factor in the elimination of herbaceous ground cover.

Water yield in this type would be inconsequential. For purposes of wildlife habitat improvement, fires in types A2 or C should be allowed to run through type A1 if thick enough to carry fire. However, no maintenance should be performed on type 1.

The quality of the water would generally consist of great amounts of sediment and appreciable higher sulfate content. Erosion of the soil is more predominant in this type.

Such soils are ideally suited to the production of chaparral. When chaparral is eliminated and grass established, only a scattering of wolf plants will result. Maintaining a poor to fair stand of grass on such sites would require difficult, costly, ineffective and frequent retreatment.

These soils often were the original sites of climax or near climax chaparral. Soil-water relationships were not condusive to the production of a dense grass cover. However, the deep rooted chaparral penetrating the fractured rock enjoyed a much better plant-soil-water relationship and thrived on such sites. These "islands" of chaparral were strategically located for the invasion of the grassland and timber soils following disturbance. Many of these stands existed as open tree type stands which produced little ground fuel and were relatively safe from wildfire, thereby serving as a natural seed source for the surrounding disturbed areas. Other similar stands had soils capable of producing sufficient ground cover to carry a fire where burned over extended periods of time. However, the sprouting chaparral created so much competition with grass that many years were required to build up sufficient ground fuel to carry a fire. These areas also served as a natural seed source for any surrounding disturbed areas.

As the chaparral stand matures, individual plants or small clumps of even-aged plants die out due to (1) old age, or (2) overuse or abuse by animals. On soil conditions such as these, there is little competition allowing a portion of the seed in the soil to sprout and develop into mature plants. Such stands tend to maintain themselves. Decadence and die-out of large portions of chaparral in this type are usually due to a past fire which provided a more uniformly aged stand. Even in the larger die-out areas, the above principles still apply and the stand maintains itself.

Although the poor water-soil relationship is most devastating to understory vegetation, its toll can also be seen in the height and density of the chaparral itself. Because of this, we can surmise certain wildlife relationships with the type. Availability of browse for forage would generally exceed that in the more productive sites where plants rapidly grow out of animals' reach. Browse composition may rate lower from a deer foraging standpoint because of the general increase of low value browse plants. Cover-wise, when this type occurs on ridges, it is especially important. Rapid escape in any direction is possible from these vantage points and are used extensively by deer.

A2. Weakly Developed Soils, with Good Moisture Storage, on Decomposed Parent Material. There are only two major soils of this type: Barkerville (Granite), and Jayarr (Diabase).

These soils have good soil-moisture values to depths of about 4 feet and are capable of supporting a permanent herbaceous ground cover, or dense stands of chaparral.

Such soils which have developed on north slopes or wetter sites have a gravelly clay loam layer which makes them unusually productive. In spite of the poor soil development, the soil-water relationship is such that plants thrive on the soils.

These soils are well adapted to chaparral and, unless a high percentage of kill is obtained, tend to revert back to chaparral.

B. Where Grass Has Reached or Will Reach Climax. Moderately productive, moderately deep and deeply developed soils, with a distinct horizon of clay accumulation - examples of these chaparral soils are: Mt. Peeley, low elevation (schist); Cinnabar (schist); Showlow (old alluvium); Balon (old alluvium).

These are developed soils which have a distinct B horizon from 10-30" below the soil surface. Such soils are well suited to the production of grass, and due to the restricted downward movement of water are not the most desirable for the typically deep rooted chaparral. Chaparral that invades these grasslands due to fire, overgrazing, or extended drought tend to remain as stunted open stands with varying degrees of remnant grass depending upon the extensiveness of the root system of the existing chaparral.

Provided that (1) grazing management is maintained over domestic livestock, and (2) disturbance does not reoccur, this type has the greatest ability to persist as a grass and forb stand. Due to the clay layer, the plant-soil-water relationships are ideally suited to the production of grass. Such sites would be expected to be mid-grass climaxes.

These sites are ideally suited to grass; and, once total conversion has been accomplished, little maintenance is required. Provided that adequate management is maintained, the stand can go for extended periods of time without maintenance due to the low mobility of chaparral species. A combination of fire and heavy grazing will convert this type back to a chaparral stand.

These soils were typically grassland climaxes and never were, nor ever will be, climax chaparral, although mottes of chaparral originally occurred in them and was the source from which the type spread. Following disturbance of the grass cover, seed was carried by birds, animals, or washed down from above and became established. The typically deep rooted chaparral was incapable of penetrating the clay layer to any great degree; consequently, the stands never reached height that they did under the other principal soil conditions. The plants developed a more lateral root system and competed with one another. Combined with competition from the remnants of grass, the stands were never able to obtain the chaparral density that they did under the other soil conditions.

Chaparral stands on these soil situations eventually die out as single plants or in even aged clumps. Desert Ceanothus will be long gone before the manzanita starts to die off. (If past disturbance, fire and/or overgrazing has been alleviated, then grass occupies the area released from competition as this die out occurs. However, if the past disturbance was overgrazing, the situation has not been alleviated, and the stands will maintain themselves.) Generally speaking, these stands can be expected to revert to climax grassland eventually.

This relationship would provide a much more desirable quality of water than would "A" above, as the top layer of soil would absorb the water and release it at a more desirable rate. Because of less slope, little erosion would be expected; thereby, providing less sediment and filtering out much of the high sulfate which is found in the Southwest.

This relationship is generally found as a grassland-chaparral savannah. This increase in interspersion makes these areas much more productive from a wildlife standpoint.

Where type A is predominantly used by deer, type B occupies many "bottom" situations and possesses a higher quality habitat for songbirds. However, the large oaks along these bottoms provide acorns which attract deer in large numbers during the fall and early winter. Where Gambel quail and javelina occupy the chaparral, they will most generally be found in this type.

C. Where Trees Have Reached or Will Reach Climax. Highly productive deep well drained soils which possess a well developed B horizon - The principal soils in this group are Arp (schist), Jacks (sandstone), Gaddes (granite), Waldroup (cinders), Lonta (old alluvium), White House (old alluvium), Mt. Peeley, high elevation (schist), Workman (diabase), and Cherry Creek (arkosic sandstone).

These are well drained soils which have formed more or less in place and possess a well developed B horizon. The plant-soil-water relationship is ideal for growing many vegetation types. This is also the high water yield portion of the chaparral type. Following burning such sites develop into a mixed stand of dense, tall chaparral. Barring any further disturbance, such sites develop into open tree type chaparral with varying degrees of grass and forbs as understory dominated by tree oaks, Arizona cypress, Ponderosa pine or Douglas fir, with chaparral as an understory. As the overstory canopy becomes taller and increases in density, the understory is gradually shaded out.

Due to the soil-water relationships of these sites, nearly any vegetation will do well on them. Grass stands upon such sites are relatively stable from the standpoint of chaparral invasion from peripheral zones. Chaparral has a very low mobility and outward movement into pure grass and forb stands. Such sites, when in the proper precipitation zone would be expected to be a climax of higher life-form vegetation such as fir, pine, Arizona cypress, oak, or pinyon-juniper. Once a total conversion to grass has been achieved, these tree species would probably be the main invaders. Due to the plant-soil-water relationships, these soils are generally the primary water yielders when treated.

Once a total conversion to grass has taken place, periodic control will maintain the stand. However, since this is the most productive chaparral type, both from a water yield and forage production standpoint, it would be highly desirable to leave islands of the more desirable species or maintain an open savannah grassland. The latter can readily be achieved through the hand application of Fenuron. Although costly, the method is highly selective, and any given composition may be achieved to satisfy the ultimate objectives.

Two entirely different conditions presently exist on these soil situations.

1. Tree Climax (fir, ponderosa pine, Arizona cypress, pinyon-juniper). Many existing chaparral stands now occupy what was once a tree climax of one form or another. Wildfire destroyed the existing tree cover and seed in the soil from preceding successional stages took over the site. On some tree sites, the preceding successional chaparral state was so ancient that few viable seed still existed. Fires on such sites were so hot as to virtually destroy the vegetation cover and allow for invasion of chaparral by the dissemination of seeds by birds and mammals. These sites, although dominated by tall, dense chaparral, are in some successional stage toward tree climax.

2. Latter successional stages of chaparral climax. Many such soil situations have either reached chaparral climax or are just entering the early successional stages to a tree climax. On such sites, there is evidence that soil development has reached the point where soil-water relationships favor trees. Scattered clumps or a thin cover of pinyon-juniper, Arizona cypress, or ponderosa pine, are just beginning to overtop the dominant chaparral.

As the stand opens up, grasses and forbs occupy the interspaces and gradually the understory. As the stand progressively opens up, trees (pinyon-juniper, Arizona cypress, ponderosa pine, or fir) emerge as individuals or small clumps. Gradually the trees overtop the chaparral which becomes understory. As the tree stand thickens and becomes taller, the chaparral is eventually shaded out and the site approaches a tree climax.

This relationship would provide the highest amount of water yield due to the deep soils and greater slope. Percolation of water into the soil would result in more springs, and, generally, a more permanent type stream flow in the canyon bottoms. With the exception of high intensity storms, very little erosion would be expected. This type would be expected to provide good water quality.

From a wildlife standpoint, this relationship's main contribution comes in the form of cover. Because of the excellent growing conditions, chaparral species rapidly grow out of reach from foraging animals. In addition, understory vegetation is rapidly shaded out. While forage characteristics of this site degrade, the cover factors improve. From a cover standpoint, this is very attractive to the illusive black bear as well as the deer.

## PRETREATMENT RECOMMENDATIONS

1. Prior to treatment, a vegetation inventory of each area should be made to the standards outlined in the Range Environmental Analysis Handbook, FSH 2209.21, R-3. A map showing vegetation types and subtypes is essential for pretreatment planning. This inventory may also be used to help design future management by domestic livestock.

2. A comprehensive soil survey should be conducted to the standards outlined in FSH 2509.15. This information, together with the vegetation map listed above, will provide realistic information for treatment of any given area.

3. The existing species composition should be considered prior to initial treatment as well as the desired composition which may be achieved through maintenance.

4. Areas treated to achieve an overstory density of 50% or less should be maintained with a minimum of 15 to 20% of the composition desirable forage species. This may be achieved through the land application of Fenuron on types A and B.

5. That plant-soil-water relationships (types A, B, C) be used in determining areas to be treated.

6. Identify the wildlife species involved. Game and Fish Department specialist will be extremely helpful.

7. Run browse condition transects through proposed treatment areas. This will afford the following information:

a. Composition of stand.
b. Density of stand.
c. Use being made of stand.
d. Index to what animals are involved and relative abundance of each species.

8. Obtain recommendations from the State Game and Fish Department and Forest Service research biologist on treatment pattern most beneficial for wildlife.

9. Where quail habitat is involved (low fringed areas), make a quail call census. (This should be made during the peak of calling period. Dates available from the State Game and Fish Department.)

10. Where turkey habitat is involved (upper fringe areas), make a gobbler call census during the peak of breeding season. (Instructions available from Range and Wildlife Division, RO.)

11. Obtain list of nesting non-game birds using habitat type planned for treatment. Check list for rare, endangered or unique species involved.

12. Where live water is being produced, establish a water monitoring station when herbicides are to be used.

13. Attempt to determine how much of the original soil has been lost due to erosion under chaparral. This is important to determine if the same productivity can be expected or not.

14. With regard to guidelines for deer habitat preservation, the following were developed by the Arizona Game and Fish Department and the Rocky Mountain Forest and Range Experiment Station at Tempe, Arizona.

a. Strips are recommended since they provide the most "edge" between cover (standing brush) and feeding areas (openings).

b. Optimum size of opening should be approximately 30-35 acres. Beyond this, ability of deer to use the area decreases.

c. Optimum width of standing brush between openings should be approximately 1/4 mile. However, width may be as little as 1/8 mile if height and density of brush is adequate to provide security to deer.

d. An isolated patch of brush in an opening is not usable as cover if less than 20 acres in dense brush or less than 40 acres in sparse brush.

e. Any existing stands of large trees, such as riparian woodland, oak islands, or isolated pine or juniper stands, are important as bedding and resting areas for deer and should be maintained.

f. Brush surrounding watering places should be maintained as needed security for deer.

g. Shrub live oak is an important deer food plant and will provide important quantities of browse and mast if left in the openings.

h. With regard to guidelines for deer habitat improvement in connection with chaparral conversion, the following have special significance:

(1). Extremely dense stands of brush preserved for cover can be improved as habitat by thinning.

(2). Legumes and other forbs will improve forage conditions for deer if added to seed mixtures for converted areas.

## MAINTENANCE RECOMMENDATIONS

1. Any given knoll, hill, or ridge may (and frequently does) have different soils with their related different vegetation on each of the different aspects. Although the parent material on all four aspects may be the same, the depth and development may be quite different. These differences must be considered when determining the type of maintenance to be performed.

2. Soil conditions (types A1, A2, B, C) should be the determining factors in pattern maintenance following broad scale burning.

3. The time of year is quite important in burning when using grass cover to carry fire. Burning at the wrong time will kill many grass species. Repeated burning at frequent intervals will seriously damage most grasses.

4. If fire is to be used for maintenance of stand density, then grazing use must provide rest for vigor one year, production to carry fire one year, and rest following the fire.

5. The maintenance method selected should be directed toward maintaining a desirable species competition.

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## TREATMENT OF CHAPARRAL AREAS

### I. Mechanical Methods

Good control of chaparral species by mechanical methods are limited to root plowing and treating with a brush rake. Both the above treatments are expensive and must be used on rock free areas with slopes of 20% or less.

By far the best opportunities in mechanical treatment present themselves in preparing the brush for selective use of fire. Such treatments as chaining, crushing, or chopping fall in this category.

## MECHANICAL METHODS FOR TREATING CHAPARRAL

| METHOD | TYPE OF EQUIPMENT | TIME | TREATMENT INITIAL | TREATMENT MAINT. | LIMITATIONS | REMARKS |
|---|---|---|---|---|---|---|
| 1. Chopping and Crushing | Martin Brush Cutter<br><br>Fleco Brush Cutter | Any time when soil is not too wet to ball or puddle. | X | | (1) Slopes 20% or less.<br><br>(2) Areas w/50% or less surface rock with no large boulders. | Will not kill brush. A good method of reducing brush to allow selective burning. |
| | Heavy Roller | Any time | X | | (1) Slopes 25% or less | (1) Since this is a rolling implement with no digging action, surface rock is not a limiting factor.<br><br>(2) No initial brush kill<br><br>(3) Use to reduce brush to allow selective burning. |
| | Tree Eater | Any time | X | | (1) Slopes 20% or less<br><br>(2) Rock free area. | (1) Reduces debris to shreads<br><br>(2) Limited to special situations because of high cost and limited areas where it can operate. |
| 2. Chaining | Chain at least 70 lbs/link. Preferable 2 to 3 chains with swivel hitches | Winter or before spring growth basins. | X | | (1) Slope wherever tractors can operate. | (1) Can be used to reduce brush for selective burning. |

| METHOD | TYPE OF EQUIPMENT | TIME | TREATMENT INITIAL | TREATMENT MAINT. | LIMITATIONS | REMARKS |
|---|---|---|---|---|---|---|
| 2. Chaining (Con't.) | | | | | (2) Where boulders will not prohibit tractor operation. | (2) Little initial brush kill. |
| | | | | | (3) Limited to mature stands. Chain will whip over young plants. | (3) Maintain constant speed of tractors where possible (2-3 miles per hour). |
| 3. Raking | Fleco brush rake | Winter | X | | (1) Slopes 20% or less | (1) This is essentially a land clearing operation. Some initial brush kill. |
| | | | | | (2) Will tolerate small amount of rock. | (2) Debris is windrowed and burnt. |
| | | | | | | (3) This operation prepares a good seed bed. |
| 4. Root Plowing | Root plow and D-8 or comparable tractor. | Winter and early spring. | X | | (1) Limited to rock free areas slopes 20% or less. | (1) Good initial brush kill (60 - 80%). |
| | | | | | | (2) Where brush is tall and dense, fire should precede root plowing for best results. |
| | | | | | | (3) Very limited use in chaparral because of selective site. |

## II. Herbicides

Use Approval:

1. No herbicide will be used for any purpose whatsoever unless it is registered for the use to which it will be put.

2. Rates of application of a herbicide will not exceed rates shown on the label. The method of application and carrier used will be in accordance with the safest methods for a specific situation and based on the latest technical information available.

3. The use of all herbicides will be approved by the Regional Forester.

4. All herbicide projects must be submitted to the Regional Pesticide Committee for screening and inclusion in the Regional herbicide program.

Application of Herbicides

Chaparral areas are best suited to helicopter application. Because of terrain and dense brush, the use of flagmen is impractical. Areas to be sprayed should be shown to the pilot at least daily and boundaries of units marked from the air with paper streamers.

Fuel break areas next to open water and other critical areas can generally be sprayed best with ground equipment. There are several trailer type sprayers which are pulled with a prime mover. On rough terrain and where the brush is dense and tall, a spray unit with saddle mounted tanks has been designed for track tractors.

Because of the higher volumes of total solution applied per acre, application with a ground rig constantly gives better kills of brush as compared to aerial application.

Safety - Aerial Application

1. Do not approach aircraft until pilot signals. Approach helicopter only from front.

2. Wind sock should be posted at loading area.

3. Only one person should work on a hopper at one time. Work only from the ground. Do not stand on helicopter skids to load hopper.

4. Fire extinguisher and first aid kit should be available at the loading area.

5. Tanks must be constructed for bottom loading.

6. Personnel at helispot must wear goggles and hardhats with chin straps.

7. Keep aircraft in signt at all times when it is working on the project.

Supervision in Application - Aerial Application

Instructions for Project Supervisors:

1. Inspect area with successful bidder prior to start of spraying. Make applicator aware of sensitive areas, terrain, and any hazards which may be encountered in application of the spray.

2. Check all ground equipment, tanks, mixers, pumps, and put in first class condition.

3. Check calibration of aircraft prior to starting work.

4. Train ground crew in advance of spraying and see that tasks are performed during spray operations.

5. Check mixing of herbicides.

6. Obtain one pint sample of herbicide concentrate from each barrel used. Use glass jars for samples.

7. Keep check on weather conditions and shut down operations according to terms of contract.

8. Arrange for placement of spray sensitive cards to check for draft droplet size and skips in coverage of spray area.

9. Enforce safety regulations at all times.

Weather Conditions

1. No aerial application of a conventional herbicide spray will be made when wind speed is greater than 5-7 miles per hour.

Invert applications will not be made when wind velocities exceed 10 miles per hour.

2. No aerial application of a conventional herbicide spray will be made when temperatures exceed 80° F.

Invert applications will not be made when temperatures exceed 90° F.

3. Thermos or inversions may occur at temperatures lower than the maximum temperatures for spraying (2 above). When such conditions occur, no spraying will be done.

4. No spraying will be done during rainy or foggy weather. Allow one hour after a rainstorm before continuing spraying.

Handling of Herbicides and Containers

1. Store all herbicides in original containers. Keep out of reach of children, pets, and livestock.

2. Keep all herbicides away from food, foodstuffs, and grass seed.

3. Read the entire label on herbicide container and follow directions.

4. Avoid inhaling herbicide sprays or dust when mixing or applying them.

5. Avoid spilling herbicide on skin or clothing. If spilled, wash off immediately with soap and water. Clothing wet with spray material should be removed at once.

6. Do not eat or smoke while working directly with herbicides.

7. Discard any herbicide container without label or damaged label. Do not guess at contents.

8. Be careful in filling or emptying spray equipment, especially on sloping ground to avoid contaminating streams or bodies of water.

9. Destroy all empty herbicide containers and bury them.

Formulations, Rates, and Time of Application

1. 2,4-D and 2,4,5-T. Large scale projects have used 2,4-D and 2,4,5-T in combination. Results to date indicate that a combination of 1 pound acid equivalent of low volatile ester 2,4-D plus 1 pound acid equivalent of low volatile ester of 2,4,5-T mixed with a cup of detergent, two quarts of diesel, and enough water to make a total solution of 8 gallons applied to one acre has been the most effective and economical mixture. Turbinella oak is the most difficult plant to kill. Three to four repeated sprayings will give good control using the above formulation.

Applications of 2,4-D and 2,4,5-T have been made in the invert form. No difference in kill is detected between invert and conventional applications. Drift was reduced by invert application when wind velocities exceeded 5 miles per hour. Applications of 2,4-D and 2,4,5-T can be made both spring and fall. Results seem to be about the same. The important point is to apply this herbicide when the plant growth is vigorous. Vigorous growth is more consistent in the spring. For this reason, spring is probably the best time to apply these herbicides. Growth is usually at its greatest between May 1-15.

Greater selectivity is obtained with fall spraying due to the difference in growth rates at this time. Fall treatments do very little damage to hollyleaf buckthorn while oak and manzanita are badly damaged.

2. Fenuron (25% active). Fenuron was applied at rates of 32 and 64 pounds total material per acre. The heavier rate is very effective, producing the best kill of any herbicide applied. If the price of this material is greatly reduced, it could well become a standard one-shot treatment. Present cost range from $65 to $93 per acre. Fenuron can be applied by either a ground crew or by helicopter equipped with a seeding attachment. Applications of Fenuron should be made during the late fall and winter period. There is no evidence that Fenuron interfers with the growth of native or seeded grasses and forbs when applied to decomposed granite soils.

SUMMARY

CHEMICAL METHODS FOR TREATING CHAPARRAL

| METHOD | TYPE OF EQUIPMENT | TIME | TREATMENT INITIAL | TREATMENT MAINT. | LIMITATIONS | REMARKS |
|---|---|---|---|---|---|---|
| 1. Aerial Conventional Application (Spray) | Helicopter | Spring - May 1-15 or Fall - Aug. 15 - Sept. 1<br><br>Sprouts should be at least 36" tall. | | X | (1) Apply when wind velocity is less than 5 mi. per hr.<br><br>(2) Watch for thermos shut down when spray is not settling to ground.<br><br>See narrative for limitations applying to all herbicides. | FORMULATIONS<br>L.V. ester 2,4-D<br>L.V. ester 2,4,5-T<br>Silvex<br><br>HERBICIDE RATES<br>2# acid equivalent per acre for any single formulation or combinations of above formulations.<br><br>CARRIER<br>1 cup of detergent<br>2 quarts of diesel plus water added to herbicide to make 8 gallons.<br><br>APPLICATION RATE OF HERBICIDE PLUS CARRIER (TOTAL SOLUTION)<br><br>8 gallons per acre. |
| 2. Aerial invert application (Spray) | Helicopter equipped to apply invert emulsions | (Same as conventional) | | X | Wind velocity maximum 10 mi. per hour.<br><br>Thermo's not as critical with invert. | Inverts when applied in right manner will eliminate drift. Comparable kills have been obtained in chaparral. Cost per acre is about 1/4 greater with inverts. Same formulations and rates are used in conventional above. |

| METHOD | TYPE OF EQUIPMENT | TIME | TREATMENT INITIAL | TREATMENT MAINT. | LIMITATIONS | REMARKS |
|---|---|---|---|---|---|---|
| 3. Aerial Hydro foil application (Spray) | Helicopter equipped with hydro foil boom | Spring - May 1-15 or<br><br>Fall - Aug. 15 - Sept. 1<br><br>Sprouts should be at least 36" tall. | | X | Wind velocity maximum 10 mi. per hour.<br><br>Thermos not a factor. | Same formulation and rates as conventional.<br><br>Boom is so constructed that no droplets smaller than 1400 microns are formed. Spray looks like a sheet of water coming down to ground. |
| 4. Aerial Fenuron (Pellets) | Helicopter with seeding attachment.<br><br>Can also be applied by ground crew | Late fall or winter<br><br>Do not apply when ground is frozen. | | X | Fenuron is applied in pellet form so wind and temperature are not limiting factors. Can be applied when it is safe to fly a helicopter. Do not apply in damp or rainy weather. | Formulation 25% active ingredients.<br><br>Rate 60#/acre. |
| 5. Ground application<br><br>Mountainous terrain | Ground spray Rigs equipped with boom | Spring - May 1-15 or Fall - Aug. 15 - Sept. 1 | | X | Wind velocity maximum 10 mi. per hour | Same herbicide and rates as for conventional spray.<br>Carrier: 1 cup of detergent, 2 qts. of diesel plus water added to make 20 gallons.<br>Application of a total solution of 20 gallons per acre. |

## III. Seeding

Competition of grass for soil moisture will reduce the total brush seedlings, but some seedlings always survive. Grass competition does not kill brush sprouts - the dominant regrowth in chaparral. Perennial grasses, usually recommended for sowing, are not competitive the first year. Herbicide applications should be used to kill the first crops of brush seedlings. Then competition from a full grass cover will limit reinvasion of brush seedlings. Thus, grass competition is an essential control measure in the long-term maintenance of a converted area (Bentley, 1967).

Fall burning, followed by chemical spraying the next spring, offers the advantage of less vigorous regrowth and may have practical application in chaparral management (Lillie, et al, 1964).

Some grass production may be obtained from seeding weeping lovegrass in areas where reduction of oak cover is slight. However, to obtain good stands and high production, more than half of the oak canopy should be eliminated (Pond, 1961).

Ungrazed stands of weeping lovegrass begin to deteriorate a few years after treatment. The decline does not appear to be related to brush cover or precipitation (Pond, 1968).

The establishment of a variety of grass and forb species in converted acreages would be preferred over a solid stand of any single species. "A Comparison of 16 Grasses and Forbs for Seeding Chaparral Burns" (Lanier and Pase, 1963) was a good piece of work and more work of this type is needed.

Very little opportunity exists to place seed in the ground with a drill in the chaparral zone. The most practical method of seeding is by broadcasting either aerial or ground.

### Broadcasting

Broadcasting of seed either by aerial or ground operation has been successful when competing vegetation has been eliminated either by mechanical methods or use of fire. Under some conditions, it is necessary to use a method of covering the seed after it has been broadcast.

Small seeded species lend themselves to broadcast seeding much better than large seeded species, simply because small seeds are covered by natural sluff. Under severe conditions, some type of a mulch has been found beneficial to use in connection with broadcast seeding. Limitations to broadcast seeding are:

1. Requires heavier seeding rates.

2. Covering of seed is poor, compared to drilling.

3. Distribution of seed is often poor.

4. Loss of seed to insects and rodents is great.

5. Establishment is often slower.

The following is a list of points which must be taken into consideration when planning and accomplishing seeding with aircraft.

Planning Seed Needs

To determine the amount of seed needed for the total project, use gross acreage. It is cheaper to seed gross area than it is to try to avoid islands and other areas that you do not necessarily want to seed. If the terrain is rough and the area has uneven edges, figure seed needs on gross acres plus 10%.

Preparation Prior to Aerial Seeding

1. Mix seed prior to scheduled aerial application.

2. Weigh and mark weight on each sack of mixed seed. Each sack should not weigh over 50 pounds. Weights are used to pre-group each load prior to actual loading operations and also to keep an estimate of seed being applied per acre.

3. Arrange for pilot to fly a reconnaissance of area to acquaint himself with area and feel out terrain and air conditions.

4. Locate helispots so that seeding can be accomplished with minimum of ferry time. Generally, one helispot per 1000 acres is sufficient. However, this will vary with layout of area to be seeded.

5. Keep seed dry. If there is a chance of rain, do not leave seed in field overnight; or provide for covering with rainproof material.

Procedure During Seeding Operation

1. Calibration of seeding rate. Place cardboard cards, one foot square, perpendicular to line of flight about 10 feet apart. Cover the cards with a light grease. Seed will stick to the greased cards. The number of seeds on each card can be counted and applied back to the desired number of seeds per square foot. The greased cards will also help determine the distribution of seed and the effective swath width.

In addition, a further determination for calibration can be made by establishing a check area of a given acreage. Let the pilot fly until he has covered about half the known acreage. Check the hoppers and adjust accordingly. This may have to be repeated a couple of times.

2. Make first seeding pass around exterior boundaries of area. This will assure seed coverage for the edges and facilitate turn-around efforts for the helicopter.

3. Fly grids against or with wind. Do not fly cross wind unless absolutely necessary.

When flying with or against wind, flight time per day can be extended considerably.

4. Flights should start as early as possible, just as soon as there is light enough for safe flight. Normally, this is the quiet time of day.

5. Winds will dictate the duration of operation in any one day. Do not seed in winds in excess of 15 miles per hour.

6. Keep track of pounds of seed and acreage covered as a check on distribution of seed and calibration of helicopter.

Procedure after Seeding Operation

1. Clean up all loading areas including sacks and loose paper.

2. Seed with poison on it should be removed from loading area and destroyed.

3. Cards used for seed counts should be removed from the field.

## SPECIES SELECTION CHAPARRAL AREA

This area includes our heavy brush type consisting of turbinella oak, manzanita, mountainmahogany, skunkbush and associated species. The ecology of much of this area is brush. Only on the certain soils is there a reasonable chance of establishing and maintaining grass on a permanent basis. Soils should be at least 20" in depth and not have over 50% rock in the soil profile.



| SPECIES | ELEVATIONAL RANGE | | |
|---|---|---|---|
| | UNDER 4500 FT. | 4500-6000 FT. | OVER 6000 FT. |
| LEHMANN LOVEGRASS | X | | |
| WEEPING LOVEGRASS | | X | X |
| BOERS LOVEGRASS | X | X | |
| SAND DROPSEED | | | X |
| TURKESTAN BLUESTEM | | X | X |
| KING RANCH BLUESTEM | X | | |
| BUSH MUHLY | X | | |
| SIDE OATS GRAMA | | X | |
| BLUE PANIC (AREAS RECEIVING ADDITIONAL MOISTURE) | X | | |
| WESTERN WHEATGRASS (ON CLAY SOILS) | | X | X |
| SMILD (AS A TRIAL) | X | X | X |
| HARDING GRASS (AS A TRIAL) | X | X | |
| CICER MILKVETCH | | X | |

(See FSH 2209.23 for mixtures and rates of seeding)

## SEMI DESERT GRASSLAND

## SPECIES SELECTION

This is the hot and dry grassland areas of the Lincoln, Gila, Coronado and Tonto Forests. Mesquite and creosote brush have increased on many acres of these grasslands.

| | SOIL TEXTURE GROUPS | | |
|---|---|---|---|
| SPECIES | SANDY | LOAM | CLAY |
| Black Grama | | X | |
| Sideoats Grama | | X | X |
| Blue Grama | | X | X |
| Lehmann Lovegrass | X | X | |
| Boers Lovegrass | X | X | |
| Plains Lovegrass | X | X | |
| Alkali Sacaton | | | X |
| Vine Mesquite | | X | X |
| Sand Dropseed | X | | |
| Bush Muhly | X | X | |
| Plains Bristle | X | X | |

(See FSH 2209.23 for mixtures and rates of seeding)

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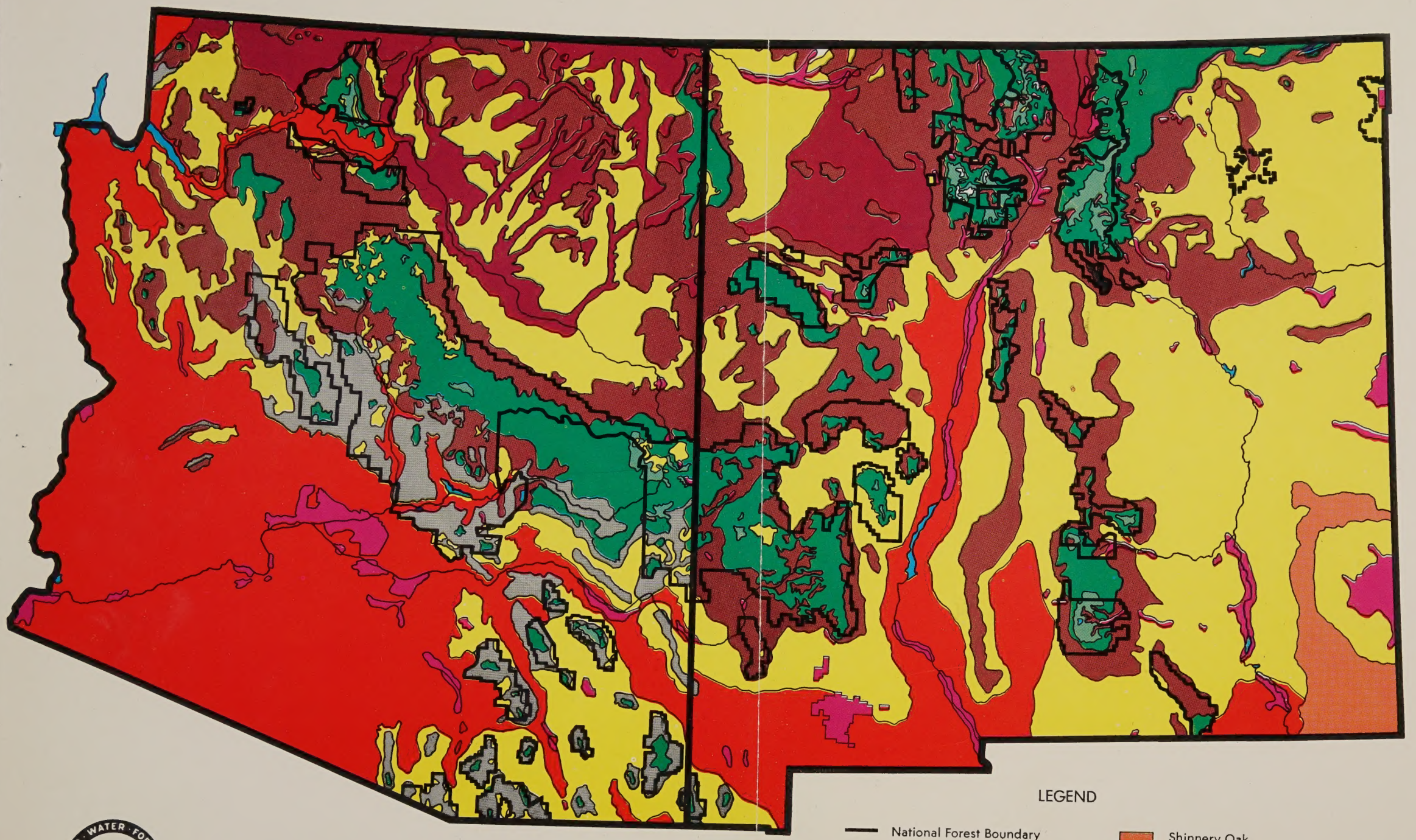
# VEGETATIVE COVER TYPES

ARIZONA

NEW MEXICO



LEGEND

- National Forest Boundary
- National Grassland Boundary
- Mixed Conifer
- Ponderosa Pine
- Pinyon — Juniper
- Chaparral
- Shinnery Oak
- Northern Desert Shrub
- Hot Desert Shrub
- Grassland
- Irrigated Lands
- Alpine Tundra
- Lakes & Reservoirs

WOOD · WATER · FORAGE · WILDLIFE · RECREATION

FOREST SERVICE · U.S. · DEPARTMENT OF AGRICULTURE

U. S. Department of Agriculture ★ Forest Service – Southwestern Region